A Prospective Study of

FUNCTIONAL OUTCOME ANALYSIS OF LONG BONE FRACTURES AND DISLOCATION WITH VASCULAR INJURY

Dissertation submitted to

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY CHENNAI

In partial fulfillment of the regulations for the award of the degree of

MS (ORTHOPAEDIC SURGERY)

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CERTIFICATE

This is to certify that this dissertation in **"FUNCTIONAL OUTCOME ANALYSIS OF LONG BONE FRACTURES AND DISLOCATION WITH VASCULAR INJURY"** is a bonafide work done by **G.Bala Subramanian** under my guidance during the period 2010–2013.

This has been submitted in partial fulfillment of the award of **M.S.** Degree in **Orthopedic Surgery (Branch–II)** by the Tamilnadu Dr.M.G.R. Medical University, Chennai.

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DECLARATION

I, **Dr.G.Bala Subramanian,** solemnly declare that the dissertation titled **"FUNCTIONAL OUTCOME ANALYSIS OF LONG BONE FRACTURES AND DISLOCATION WITH VASCULAR INJURY"** was done by me at the Rajiv Gandhi Government General Hospital, Chennai-3, during 2010-2013 under the guidance of my unit chief **Prof.N.Deen Mohamed Ismail, M.S(Ortho), D.Ortho.**

The dissertation is submitted in partial fulfillment of requirement for the award of M.S. Degree (Branch –II) in Orthopaedic Surgery to **The Tamil Nadu Dr.M.G.R.Medical University.**

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CONTENTS

INTRODUCTION

Trauma frequently involves the bones of the extremities. This can also involves the vessels of the extremities either directly from the initial injury or secondarily from the fragments of the fractured bone. The successful management of patients with lower extremity arterial injuries has two goals. The first is to save the patient's life and the second is to save the extremity and the function of the limb.

With advanced improvement of arterial repair and regaining the vascularity of the limb , issues to be noted are methods of fracture management and complications associated with it . Also adequate vascularity of the limb is needed for the fracture union. As a result there can be delay in union or non-union of the fracture fragments. Also decreased vascularity alters the local immunity leading to development of infection.

Time to intervene for skeletal fixation whether prior to vessel repair or after it has to be decided upon. Peripheral arterial injuries occur 90% in the extremity associated with fractures and dislocation. Early mobilization of the limb prevents the development of muscle atrophy and makes the patient to return to his daily activities.

Popliteal artery injuries are among the most challenging of all extremity vascular injuries. The outcome depends predominantly on the force of injury. The popliteal vein and popliteal nerve are frequently involved associated injuries with popliteal artery.

Popliteal artery (20% to 60%)[10] is at risk during traumatic dislocation of the knee owing to the bowstring effect across the popliteal fossa secondary to proximal and distal thethering.

HISTORICAL REVIEW

During world war II arterial injuries were routinely ligated. For popliteal artery injuries amputation rate was 73% The poor results of arterial ligation prompted Hughes to perform repair of of peripheral arterial injuries during the Korean war

Rich[14] and associates reported further refinements of arterial repair during the Vietnam war decreasing the amputation rate for popliteal artery injuries to 32%. Continuing refinements in arterial surgery over the decades have reduced limb loss in most civilian series to less than 10% to 15%. In 20 to 50% of patients associated skeletal and nerve injuries produces long term disability.

In a series of 100 blunt popliteal artery injury by Wagner[14] reported that popliteal artery thrombosis and transaction occurred in 97 . Concomitant popliteal vein injuries was present in 29%. They repaired the artery by end to end ansastamosis in 49%,intimal repair and vein patch in 2%,Thrombectomy in 1% and vein interpositionin 43% . 10 amputation was required because of failure of arterial repair . 5 were necessitated by invasive limb sepsis or massive soft tissue injury.

Guerrero[19] and colleagues reported that in popliteal artery injury there an increased rate of limb loss .

Melton and associates in 102 patients issued systemic or local thrombolysis with blunt or penetrating arterial injury and found a decrease in amputation rate. All patients with MESSb; score > 8 required amputation.

In a retrospective study by Dar and Collegues in 272 patient with traumatic popliteal arterial injury they analysed penetrating injury was the cause in 95 % of patients .Amputation rate in their series was 5.5%. Variables included by them are delay in vascular repair of >12 hr and associated bone fracture.

Boisrenoult[5] in his study on vascular lesions associated with bicruciate and knee dislocation ligamentous injury advocated ankle brachial index as a diagnostic tool for vascular lesions. Abou-Sayed and Mills sets a threshold for ABI at <0.9 whereas Hollis sets at <0.8 to detect vascular lesions .Threshold of<0.9 has a 95-100% of sensitivity and 80- 100% specifity in detecting vascular lesions.

Selective arteriography[16] is initial screening test based on physical examination to determine whether the patient need artiography or immediate vascular surgery. The protocol is to

examine the distal pulses distal to the injury for its presence and intensity and compare with the opposite normal extremity. Also the extremity is examined for colour and temperature. If there is asymmetry between the two immediate vascular intervention should be done immediately with arteriogram immediately at the theatre. Otherwise patient can be admitted and serial examination is done. Formal arteriogram can be done to determine the need for vascular procedure.

AIMS AND OBJECTIVES

Aim of this study was to evaluate

- The pattern of fractures and dislocations associated with vascular injury of extremities at our institution
- Outcomes of fracture union, function of the limb and complications in relation to fracture pattern and modality of treatment.

ANATOMY

FEMORAL ARTERY

Common Femoral artery[17] is the continuation of external iliac artery distal to the inguinal ligament. At the level of the midpoint of inguinal ligament and deep to it, it enters the femoral triangle .It is about 4 cm in length then it divides into superficial femoral artery and profunda femoris artery. In the femoral triangle it lies between the femoral vein and femoral nerve which is bounded by inguinal ligament above, Sartorius laterally, adductor longus medially and roof by fascia lata.

The largest branch of femoral artery and the chief artery to thigh is proundafemoris artery which arises from the lateral aspect femoral artery in the femoral triangle and arches posteriorly. And continues downwards upto middle of thigh where it is separated by the adductor longus from the femoral artery and femoral vein. Three to four perforating arteries arises from the profundafemoris artery which supplies muscles of all three compartments of thigh

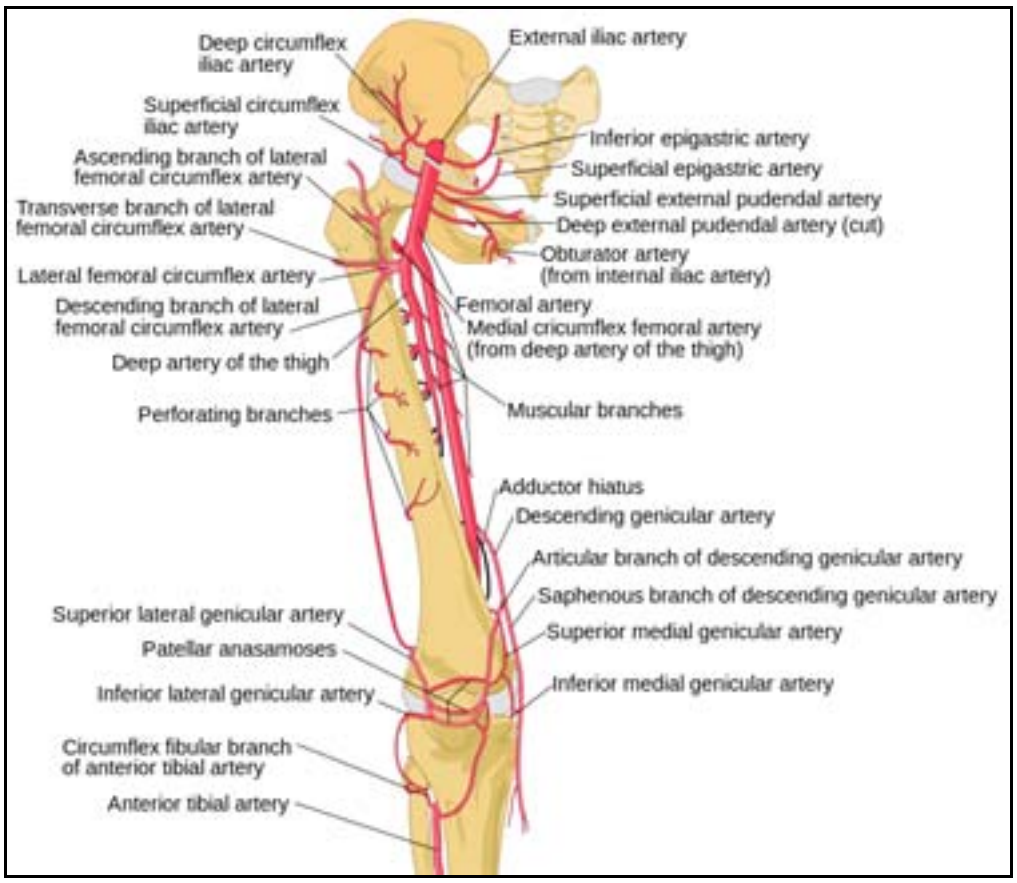


Fig: 1

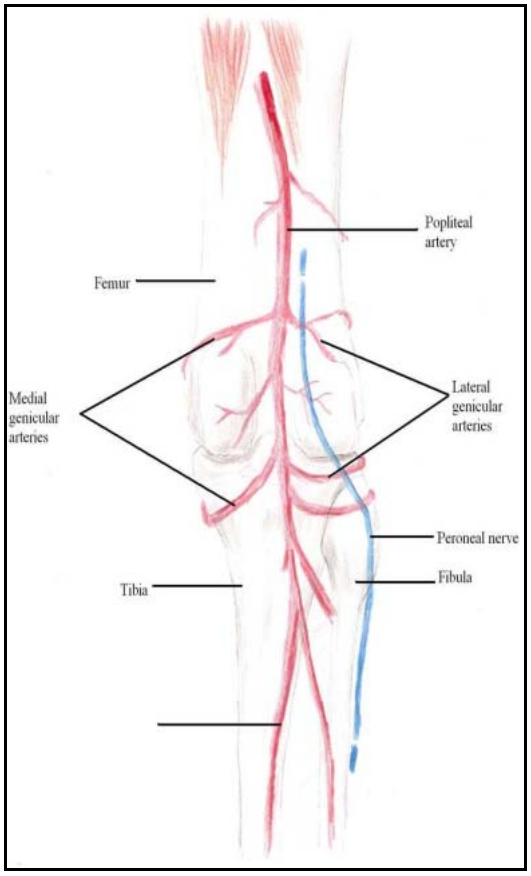
POPLITEAL ARTERY AND ITS RELATION TO BONE[10]

Femoral artery continues as popliteal artery at the hiatus of adductor magnus muscle.It is anchored upon the medial femoral epicondyle by the tendinous insertion of adductor magnus . Then it runs posterior to the distal femur behind the knee joint. It gives off blood supply to the knee at the supracondylar ridge. The following branches are given above the level of knee

- ❖ medial and lateral sural arteries
- ❖ middle genicular artery

- cutaneous branch accompaniying small saphenous vein

At the level of knee behind the posterior horn of lateral meniscus lies the popliteal artery. Behind the posterior horn of lateral meniscus popliteal artery is separated from posterior capsule by a thin layer of fat. At the level of knee it gives of medial and lateral genicular arteries. There are 5 genicular arteries which form the periarticular arterial anastamosis . During full knee flexion popliteal aretery may kink reducing the blood supply to leg which is prevented by the collateral circulation formed by the genicular arteries. In 90° of knee flexion popliteal artery lies anterior to the popliteal vein and 9 mm posterior to posterior aspect of tibial plateau. Muscular branches of popliteal artery supplies the hamstring,gastronemius,soleus and plantaris muscle. The tendon of soleus muscle fixes the poplitael artery to the bone while the muscle descends from its insertion on the medial aspect of tibial plateau. It divides into its terminal branches Anterior and Posterior tibial arteries at the lower end of popliteus muscle before entering deep to the fibrous arch of soleus muscle.



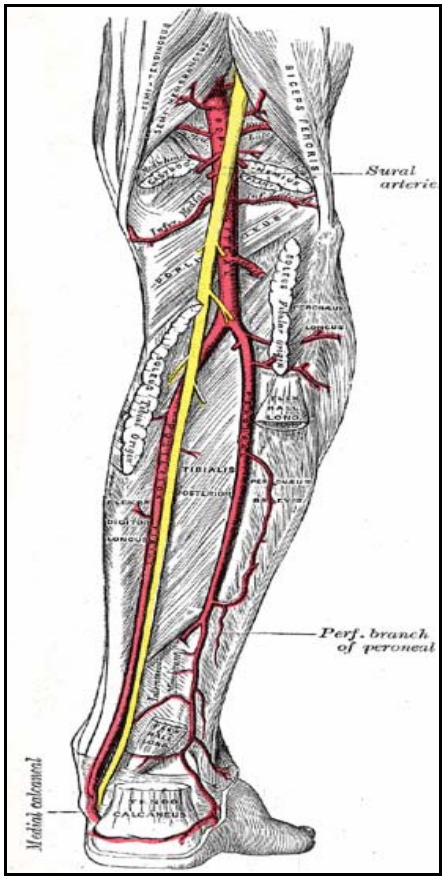


Fig:2 & Fig:3

ARTERIES OF THE LEG[17]

Posterior tibial artery is the larger and direct terminal branch of the popliteal artery supplying the posterior compartment of the leg and foot.Its begins deep to the tendinous arch of soleus at the distal border of popliteus and bifurcates into its terminal branches immediately.Close to its origin it gives of its largest branch fibular artery which runs parallel and lateral to it within the deep posterior compartment.

Posterior tibial artery is accompanied by the tibial nerve and veins. It lies behind the tibialis posterior.Distally it runs posterior to the medial malleolus .From the malleolus it was separated by the tendons of tibialis posterior and flexor digitorum longus.Below the malleolus it lies between the tendon of flexor hallucis longus and flexor digitorum longus. It divides into medial and lateral planter arteries deep to the flexor retinaculum.

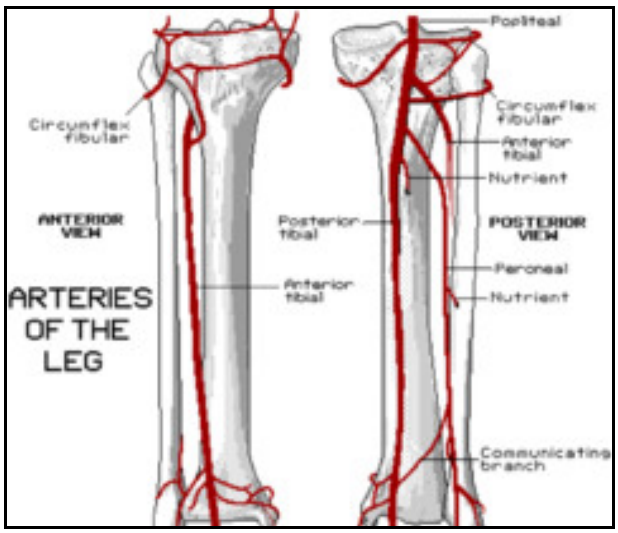


Fig: 4

Peronneal (fibular artery) after arising from the posterior tibial artery descscends towards the fibula obliquely and within the flexor hallucis longus it descends in the posterior compartment along the medial side of fibula .It gives of muscular branches to the posterior and lateral compartment of leg.It also gives nutrient artery to fibula.

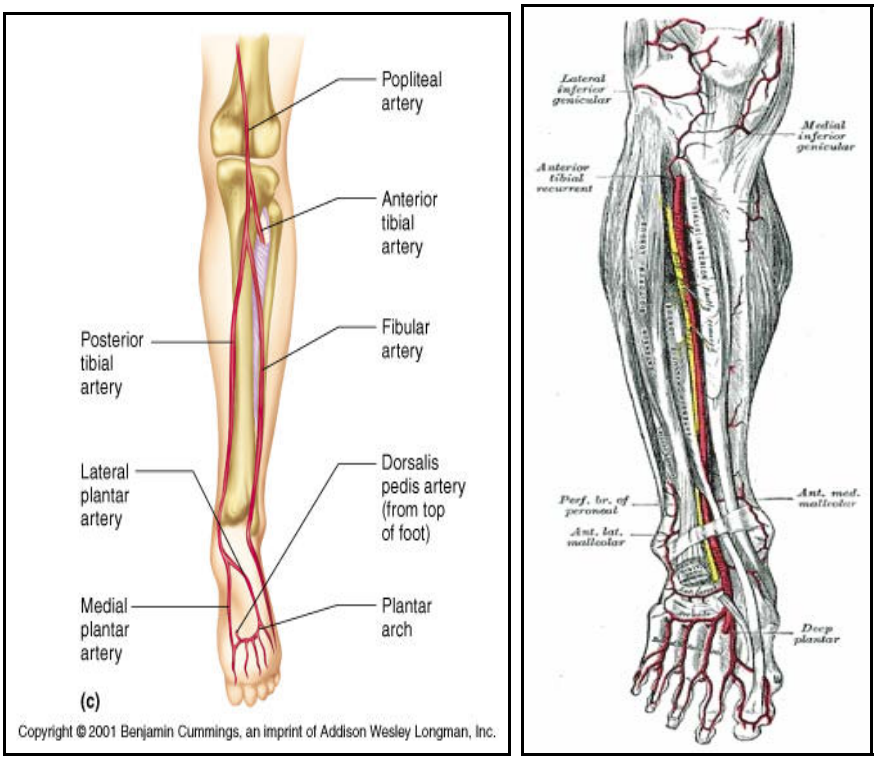


Fig: 5 & 6

Anterior tibial artery a smaller terminal branch of the popliteal artery begins at the inferior end of the popliteus muscle.The artery then passes immediately into the anterior compartment through a gap in the superior aspect of the interrosseus membrane. It descends along the anterior surface of the membrane between the tibialis anterior and extensor digitorum longus .At the level of ankle joint it passes midway between the malleoli and it was named here as dorsalis pedis artery.

BRACHIAL ARTERY AND ITS RELATION

Brachial artery [10] is the predominant blood supply of arm . At the lower end of teres major muscle axillary artery continues as

brachial aretry .Artery is superficial throughout its course running anterior to the triceps and brachialis. Initially it lies medial to the humerus and can be palpable in the medial bicipital groove. Then it passes anterior to the medial supracondylar ridge and trochlea of humerus. In the elbow it lies medial to the tendon of biceps.

Deep artery of arm (profunda brachii) artery is the largest branch of brachial artery .It arises most superiorly and passes posteriorly around the shaft of humerus accompanied by radial nerve along the radial groove. It terminates by dividing into middle and radial collateral arteries.

Superior and inferior ulnar collateral arteries branches of brachial artery form periarticular arterial anastamosis around the elbow. It is easily palpable at the elbow medial to the biceps tendon.In the cubital fossa it divides into its terminal branches of radial and ulnar arterioes opposite to the neck of radius.

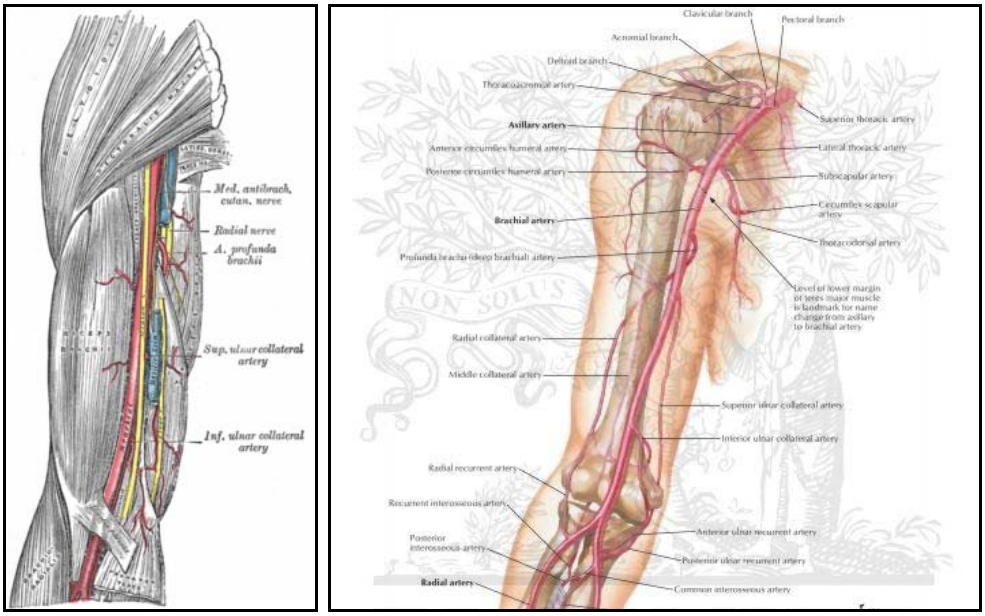


Fig: 7 & 8

Brachial artery is closely related to the median nerve.Proximally it lies lateral to the brachial artery.Then it crosses to the medial side and lies anterior at the level of elbow joint.

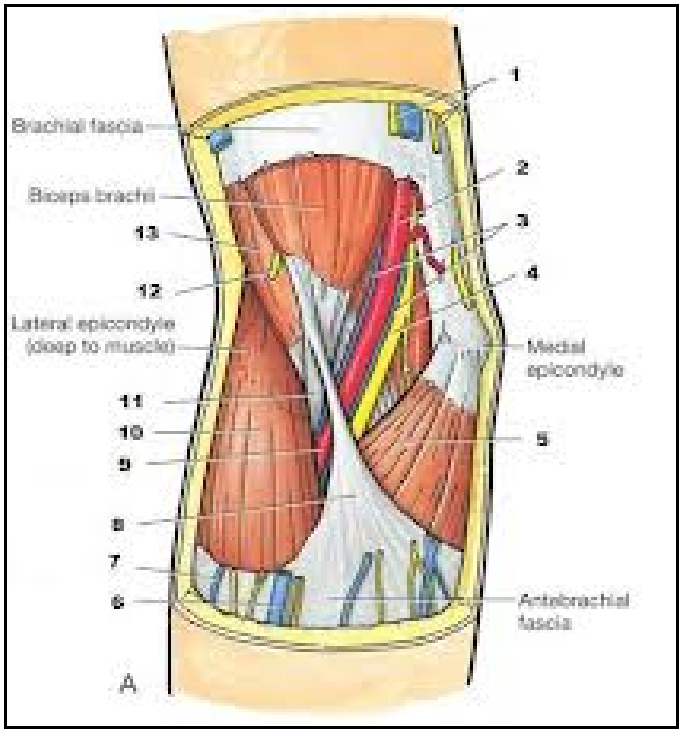


Fig: 9

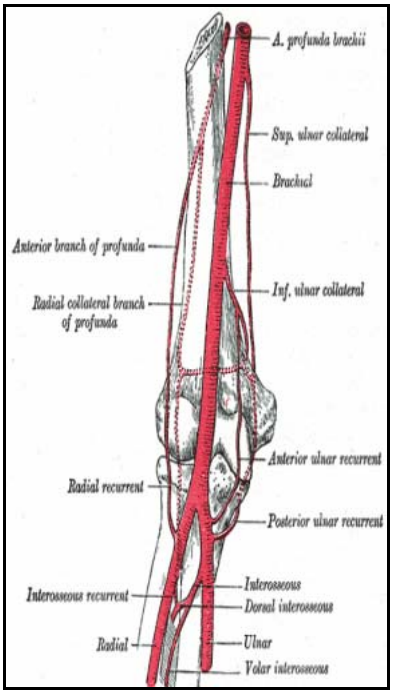


Fig: 10

ARTERIES OF FOREAREM

Ulnar and radial arteries are the arteries of the forearm.They are the terminal branches of the brachial artery arises opposite to the neck of radius.Ulnar artery then passes lateral to flexor carpi ulnaris tendon.There it lies anterior to the ulnar head .On the medial side of ulnar artery lies the ulnar nerve. In the forearm it passes deep to superficial and deep layers of flexor muscles to reach the medial side of fore arm. At the level of the wrist it passes superficial to flexor retinaculum in guyons canal to enter hand

Ulnar artery gives branches of

1) 1. Anterior and posterior ulnar recurrent arteries which took part in periarticular arterial anastamosis.

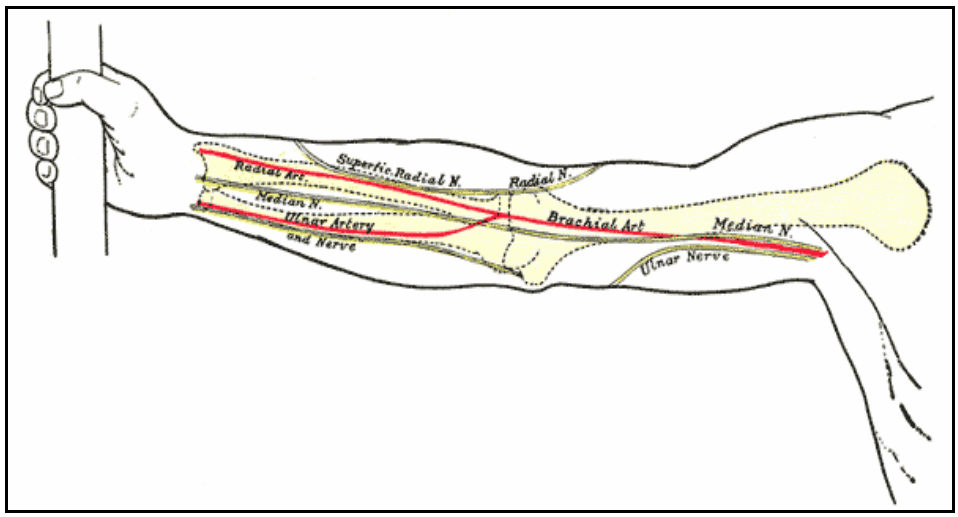


Fig: 11

2.Common interosseous artery arises at the distal part of the cubital fossa and immediately it divides into anterior and posterior interosseus artery. Anterior interosseous artery runs directly on the anterior aspect of interrosseous membrane along with the anterior interosseous nerve. And Posterior interosseous artery runs along with the posterior interoaaeous nerve on the extensor aspect of forearm between the superficial and deep layers of extensor muscles.

Radial artery runs along anterolateral aspect of forearm .It helps in the anterolateral demarcation of the flexor and extensor

compartments of forearm.When brachioradialis is pulled laterally entire length of the artery is visible.

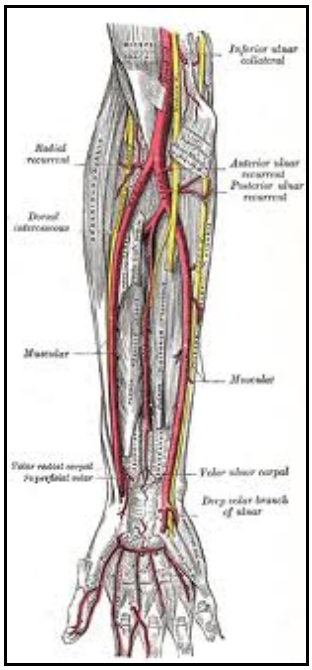


Fig: 12

Throughout its course it lies over the muscle till it reaches distal part of fore arm. Distally it lies over the anterior aspect of radius covered only by skin and fascia,making it an ideal place to check for the radial pulse.

Surface anatomy of radial artery is represented by a line joining the midpoint of the cubital fossa to a point just medial to the radial styloid process.

Branches of radial artery are

1) Radial recurrent artery involved in periarticular anastamosis around the elbow along with radial collateral artery.

2) Palmar and dorsal carpal branches of radial artery participate in the periarticular arterial anastamosis around the wrist.

APPROACHES

POSTERIO MEDIAL APPROACH TO DISTAL FEMUR AND ARTERY [11]

The medial approach is useful primarily for repair of the femoral artery; usually such arterial injuries are associated with fractures. It is also occasionally useful for medial internal fixation of fractures .

- With the patient supine and the hip externally rotated and flexed , position the knee in flexion. Incision is made at the mid thigh parallel to the Sartorius along its lateral margin and extend the incision distally to 5 cm distal to the adductor tubercle . Incise the superficial fascia and the deep fascia, which is quite thin in this region. Avoid the saphenous vein and nerve, which are superficial.

- Identify the anterior edge of the Sartorius ditally, which falls posteriorly with progressive knee flexion. Then Mobilize the adductor tendon anteriorly to gain exposure to the midline of the distal femur.

- Incise its fascia with care posteriorly . Posterior to the adductor, at the level of adductor canal the popliteal vessel is

visible and, the tibial branch of the sciatic nerve is visible more deeply. Then place the internal fixation plates anterior to the adductor tubercle after performing subperiosteal dissection .

Below the knee popliteal artery is visible through a medial calf incision one finger breadth below the tibial margin.Once the deep fascia has been incised medial head of gastronemius is visible which is retracted inferiorly.Artery lies medial to the popliteal vein.By extending the medial calf incision posterior tibial and peronneal arteries can be visualized.The exposure of these vessels can be increased by dividing the soleus at its medial origin from the tibia.

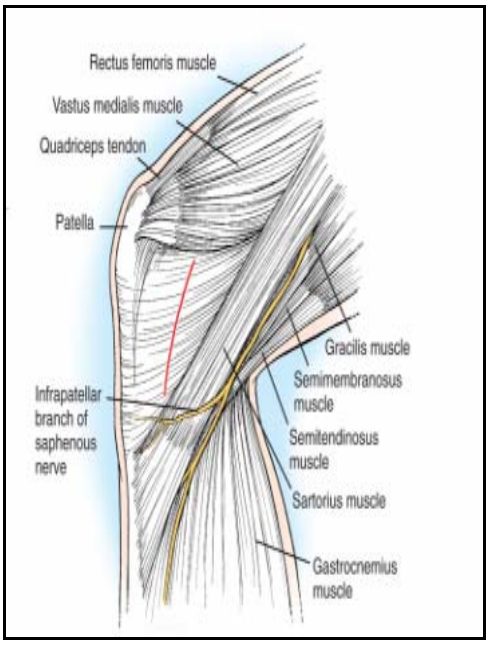


Fig: 13

POSTERO MEDIAL APPROACH TO PROXIMAL TIBIA:

Position the patient supine then abduct and externally rotate the leg .

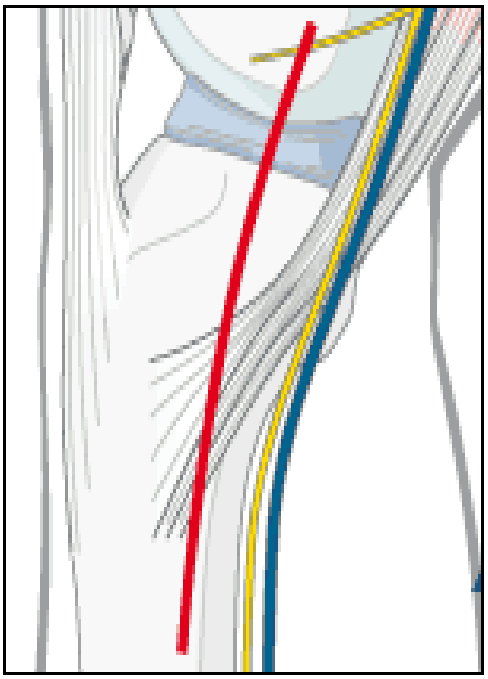


Fig: 14

With slight flexion in the knee incision is made from the medial epicondyle towards the postero-medial edge of the tibia either a straight bone or a slightly curved one. Both proximally and distally it can be extended depending on the need of exposure. Avoid the saphenous nerve and vein during subcutaneous dissection.Place the incision as posterior as possible to allow the implant to be placed from the posterior aspect of the tibia without the posterior skin flap obstructing the skin paths.

APPROACH TO BRACHIAL ARTERY AND SHAFT OF HUMERUS [13]

In the upper arm incision is made just behind the biceps muscle.skin and fascia incised along the same incision triceps is visualized and retracted posteriorly and biceps is retracted anteriorly. Superior to the brachial artery lies the median nerve . Brachial vein is visualized on further dissection which is retracted posteriorly to expose the ulnar nerve. Bone is visualized once the muscles are retracted and plating can be done on the medial aspect.

At the level of elbow for exposure of the brachial artery S shaped incision is made over the anticubital fossa.Then the bicipital aponeurosis is divided .once aponeurosis is divided brachial artery and its bifurcation into radial and ulnar artery is seen passing between the brachioradialis and flexor muscles.The brachial vein and median nerve is seen running posteromedial to the artery.

COMPARTMENT SYNDROME

- Compartment syndrome[9] is defined as an elevation of the interstitial pressure in a closed osseofascial compartment .

- Compartments with relatively noncompliant fascial or osseous structures most commonly are involved, especially the deep posterior and anterior compartments of the leg and the volar compartment of the forearm.

- Compartment syndrome can develop at any site where the skeletal muscle is surrounded by tight fascia, such as in the thigh, buttock,shoulder, hand, arm,foot and lumbar paraspinous muscles

- Compartment Syndrome is classified into Acute or Chronic depending on the cause and duration of symptoms.

- Causes of Acute Compartment Syndrome are:

  - Fractures
  - Soft tissue injury
  - Arterial Injury
  - Limb Compression during altered consciousness
  - Burns

PATHO PHYSIOLOGY

Acute compartment syndrome alters the normal tissue homeostasis leading to increased tissue pressure, decreased capillary blood flow and tissue necrosis resulting from oxygen deprivation. Studies shows that if intracompartmental pressure is more than 30 mm Hg for more than 8 hrs muscle necrosis occurs. Higher pressure causes greater compromise of neuromuscular viability at a shorter period of time.

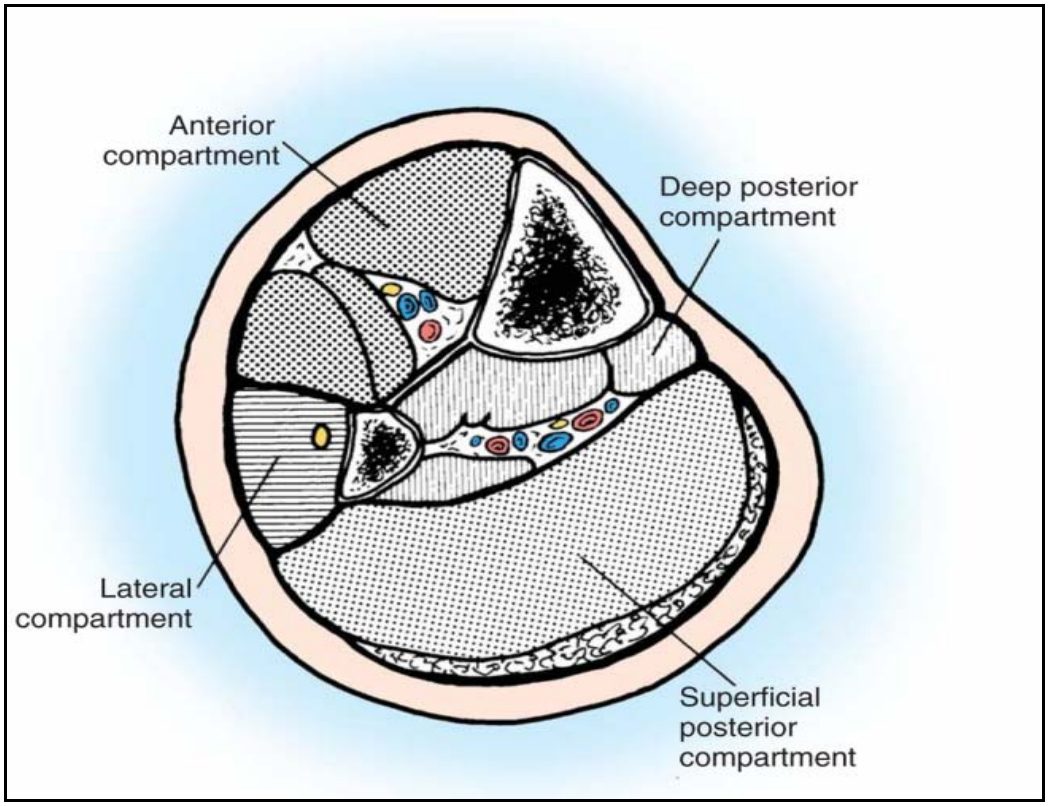


Fig: 15

PHYSICAL SIGNS OF ACUTE COMPARTMENT SYNDROME

1) Tense compartment

2) Passive stretch pain

3) Paresis

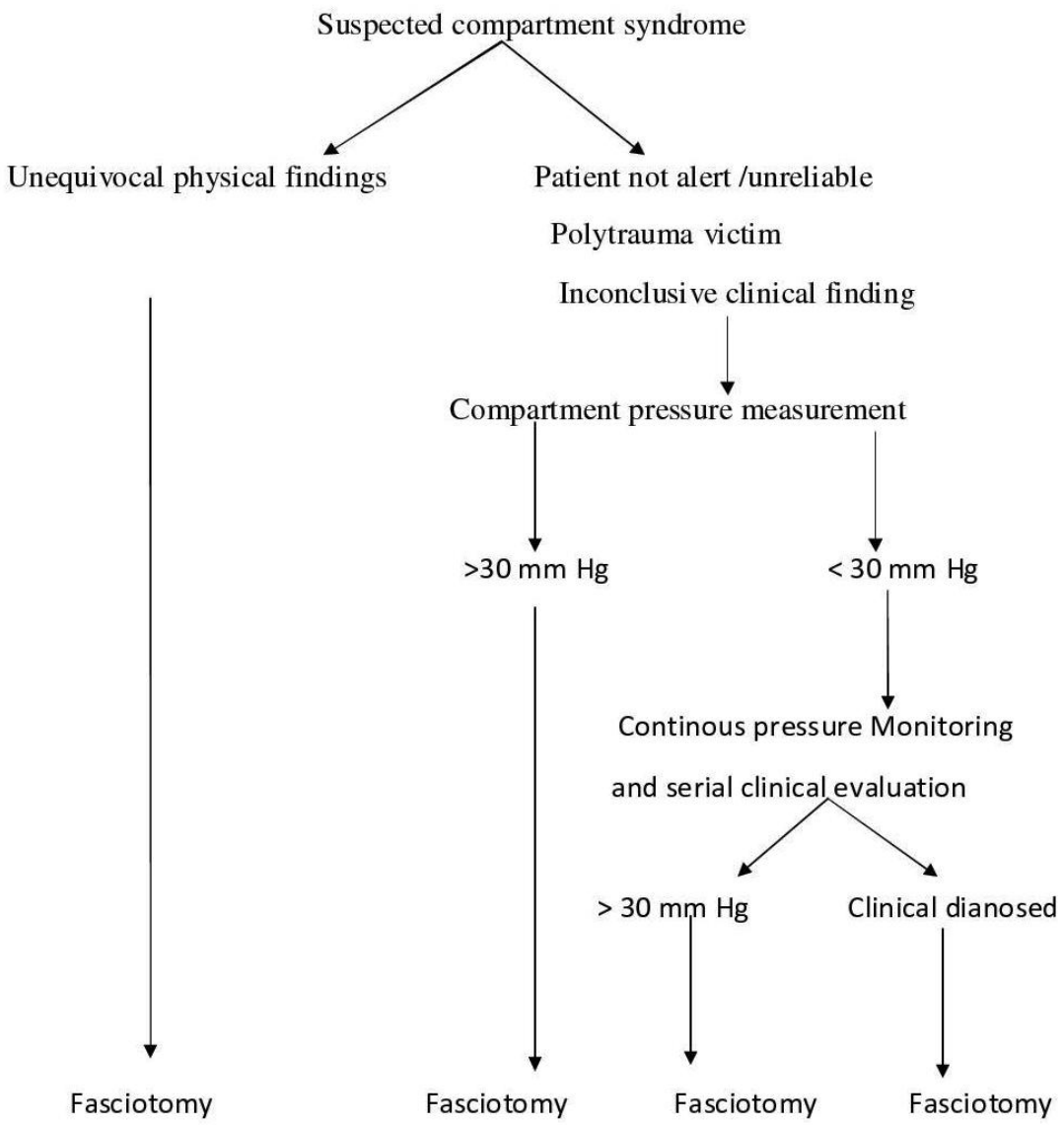
4) Hypesthesia or paresthesia (pinprick, light touch, and 2-point discrimination).

5) The most important sign is pain out of proportion to that expected with the injury.

- The diagnosis of acute compartment syndrome may be delayed in patients in whom physical examination cannot be done accurately such as in children, patients with multiple injuries and patients with altered consciousness.

- If compartment syndrome is suspected and an adequate examination cannot be performed, pressure levels should be measured.Pressure levels are monitored by simple equipment as described by whitesides et al.He used a syringe ,intravenous tube,a three way stopcock and a mercury manometer.

Fasciotomy:


Suspected compartment syndrome
Unequivocal physical findings
Patient not alert /unreliable
Polytrauma victim
Inconclusive clinical finding
Compartment pressure measurement
>30 mm Hg
< 30 mm Hg
Continous pressure Monitoring
and serial clinical evaluation
> 30 mm Hg
Clinical dianosed
Fasciotomy
Fasciotomy
Fasciotomy
Fasciotomy

DOUBLE INCISION FASCIOTOMY[9]

Incision of about 20 to 25 cm is made midway between the fibular shaft and crest of the tibia. Subcutaneous dissection is done for wide exposure of fascial compartments. To expose the lateral intermuscular septum a transverse incision is made. In line with the anterior margin of tibia anterior compartment is released proximally and distally. In line with the fibular shaft lateral compartment is released proximally and distally.

About 2cm posterior to the posterior margin of tibia longitudinally second incision is made. By subcutaneous dissection identify the fascial planes. Retract the saphenous vein and nerve anteriorly.Then identify the septum between the superficial and deep posterior compartment by a transverse incision .

Release the fascia of the compartment over the length of gastronemius soleus complex. Deep posterior compartment is released by fascial incision over the Flexor digitorum longus. After release of posterior compartment look for tension in deep posterior compartment if increased tension is present release it over the entire muscle belly.

Management of fasciotomy wounds include primary closure, healing by secondary intention and SSG to cover defects.

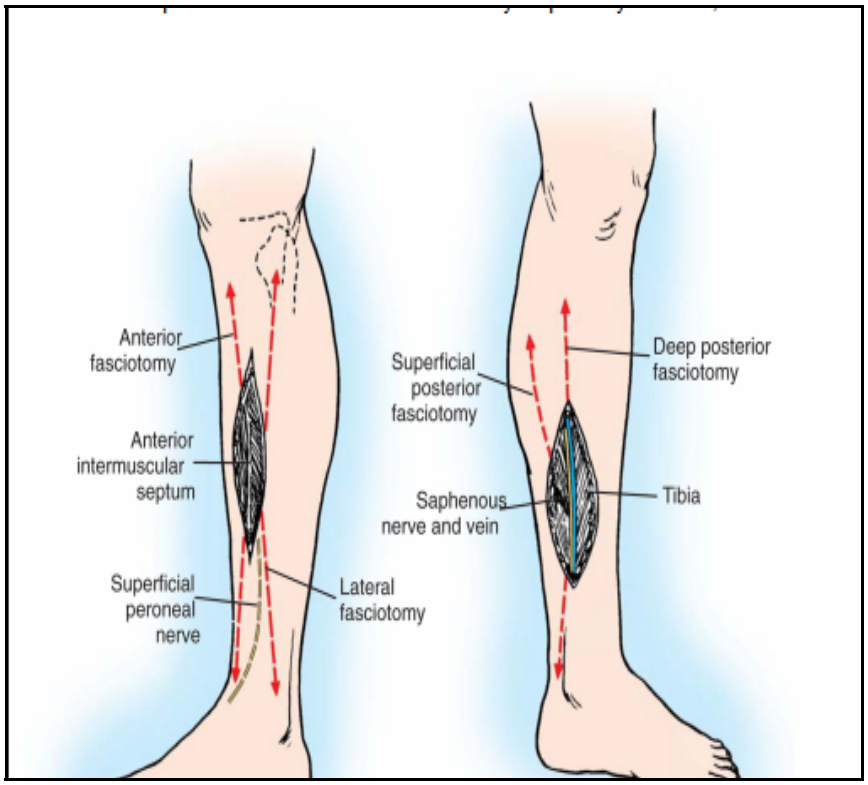


Fig: 16

Once the compartment syndromedeveloped in such cases 20% mannitol is given before reperfusion as it decreases the tissue edema and increases the urine volume.

MECHANISM OF INJURY

The initial and ultimate outcome of vascular injury depend on large part on the wounding agent or mechanism of injury.

It can be

1) Blunt trauma

2) High velocity penetrating trauma

3) Low velocity penetrating trauma

Motor vehicle accident and fall are the most frequent cause with increasing mobility of modern society.

KNEE DISLOCATION

In anterior dislocation[10] popliteal artery is stretched due to hyperextension of knee. It produces intimal separation of popliteal artery over long segment. As greater force is needed to overcome the strength of extensor muscles of leg so posterior dislocation is less common. Popliteal artery usually suffers direct contusion or intimal fracture in posterior dislocation.

CLINICAL FINDINGS

Extremity arterial injuries[14] have varied clinical presentation Symptoms will be unaccustomed severe rest pain and passive stretch pain. Signs of traumatic vascular injury are hard signs and soft signs.

HARD SIGNS

1) Observed pulsatile bleeding

2) Arterial thrill by manual palpation

3) Bruit auscultated over or near an area of arterial injury

4) Absent distal pulses

5) Visible expanding hematoma

SOFT SIGNS:

1) Significant heamorhage by history

2) Diminished pulse compared with contralateral extremity

3) Neurological abnormality

4) Proximity of bony injury or penetrating truma

CLASSIFICATION

Acute Limb Ischemia by Society of Vascular Surgery[14] and International society of cardiovascular surgery

Category	Prognosis	sensory loss	Muscle weakness
I Viable	Not immediately threatened	None	None
II Threatened			
IIa Marginally threatened	salvageable if promptly treated	minimal(toes) or None	None
IIb Immediately threatened	Salvageable with immediate revascularisation	More than toes or rest pain	Mild to moderate
III Irreversible	Major tissue loss permanent nerve damage	Profound anaesthetic	Profound paralysis

Category	Doppler signal	
	Arterial	Venous
I	Audible	Audible
IIa	Inaudible	Audible
IIb	Inaudible	Audible
III	Inaudible	Inaudible

Class I	:	Acute onset claudication, thrombolysis is risky and argument for conservative treatment with exercise and medical therapy.
Class IIa	:	Time for investigation and semielective intervention Acute Sub Critical Ischemia
Class IIb	:	Any delay in treatment risk irreversible muscle necrosis Acute Critical Ischemia
Class III	:	No indication to improve blood supply which may risk Rhabdomyolysis. so the decision is between major amputation and conservative treatment

AMPUTATION VERSUS LIMB SALVAGE [9]

Several attempts have been made to evaluate injuries better and identify injury patterns that would be best be treated by early amputation. Helfet et al in his study showed limbs with MESS scores of 7 to 12 required amputation whereas limb with scores of 3 to 6 were viable. MESS Score is based on four group systems. Whittle et al in his study found MESS score to be good predictor of amputation. Bonnani et al in a prospective study found that its high specificity used to predict the limb salvage potential while low sensitivity does not support the validity of score for amputation.

SKELETAL/ SOFT TISSUE GROUP

1.	Low energy: Stab wounds,simple closed fractures, small caliber gun shot wounds	1
2.	Medium energy: Open or multiple level fractures, dislocation, moderate crush injury	2
3.	High energy : Shot gun blast (close range), high velocity gunshot Wounds	3
4.	Massive crush: Logging ,rail road, oil rig accidents	4

SHOCK GROUP

1.	Normotensive hemodynamics: blood pressure stable in field and in operating room	0
2.	Transiently hypotensive: blood pressure unstable in field but responsive to intravenous fluid	1
3.	Prolonged hypotensive: Systolic pressure <90 mm Hg in field and responsive to intravenous fluid only in operating room	2

ISCHEMIA GROUP:

1.	Mild - Diminished pulse without signs of ischemia	1
2.	Moderate - No pulse by doppler,sluggish capillary refill paresthesia,diminished motor activity	2
3.	Advanced - Pulseless, cool, paralysed and numb without capillary refill	3

AGE GROUP

1.	< 30 yr	0
2.	30-50 yr	1
3.	>50 yr	2

If ischemia time is >6hr add 2 points

GUSTILO ANDERSON CLASSIFICATION OF OPEN WOUND

Grade I : Clean wound <1cm long, minimal muscle contusion and simple transverse or short oblique fractures

Grade II: Laceration >1cm long, minimal to moderate crushing component simple transverse or short oblique fractures

Grade III: Extensive soft tissue damage including muscles skin and\ neurovascular structures

IIIA: Open fractures with extensive soft tissue laceration but have adequate bone coverage or segmental or severely comminuted fractures even with 1cm laceration

IIIB: Open fractures with extensive soft tissue loss with periosteal stripping and bony exposure . usually massively contaminated

IIIC: Open fractures with an arterial injury requiring repair regardless of size of soft tissue wound

RAJASEKARAN ET AL INJURY SEVERITY SCORE FOR GUSTILO TYPE IIIA AND IIIB OPEN TIBIAL FRACTURES

I COVERING STRUCTURES : SKIN AND FASCIA

Wounds without skin loss

Not over fracture : 1

Exposing the fracture : 2

Wounds with skin loss

Not over fracture : 3

Over the fracture : 4

Circumferential wound with skin loss - 5

II Skeletal structures : Bone and joints

Transverse or oblique fracture or butterfly fragment <50% circumference	1
Large butterfly fragment >50% circumference	2
Comminution or segmental fractures without skin loss	3
Bone loss < 4cm	4
Bone loss > 4cm	5

III Functional tissues: Musculotendinous and Nerve units

Partial injury to musculotendinous unit	1
Complete but reparable injury to musculotendinous unit	2
Irreparable injury to musculotendinous unit,partial loss of a compartment or complete injury to posterior tibial nerve	3
Loss of one compartment of musculotendinous unit	4
Loss of two or more compartment of musculotendinous unit or subtotal amputation	5

IV Comorbid conditions: Add 2 points for each condition present

1) Injury leading to debridement interval > 12 hr

2) Sewage or Organic contamination or farmyard injuries

3) Age >65 yr

4) Drug dependent diabetes mellitus or cardio respirator disease leading to increased anaesthetic risk

5) Polytrauma involving chest or abdomen or fat embolism

6) Hypotension with systolic blood pressure < 90 mm Hg at presentation

7) 7. Another major injury to same limb or compartment syndrome

Group1 had a scores of 5 or less, group 2 had scores of 6 to 10, group 3 had scores of 11 to 15 and group 4 had scores of 16 or greater. Score of 14 or greater as an indicator for amputation had a sensitivity of 98% , a specifity of 100% ,a positive predictive value of 99% and negative predictive value of 70%.These were similar to the MESS score of 99% sensitivity,97% positive predictive value, but better than the 17% Specifity and 50% negative predictive value.The higher specificity of ganga hospital score make it a much predictor of amputation.

IMAGING

RADIOGRAPHY:

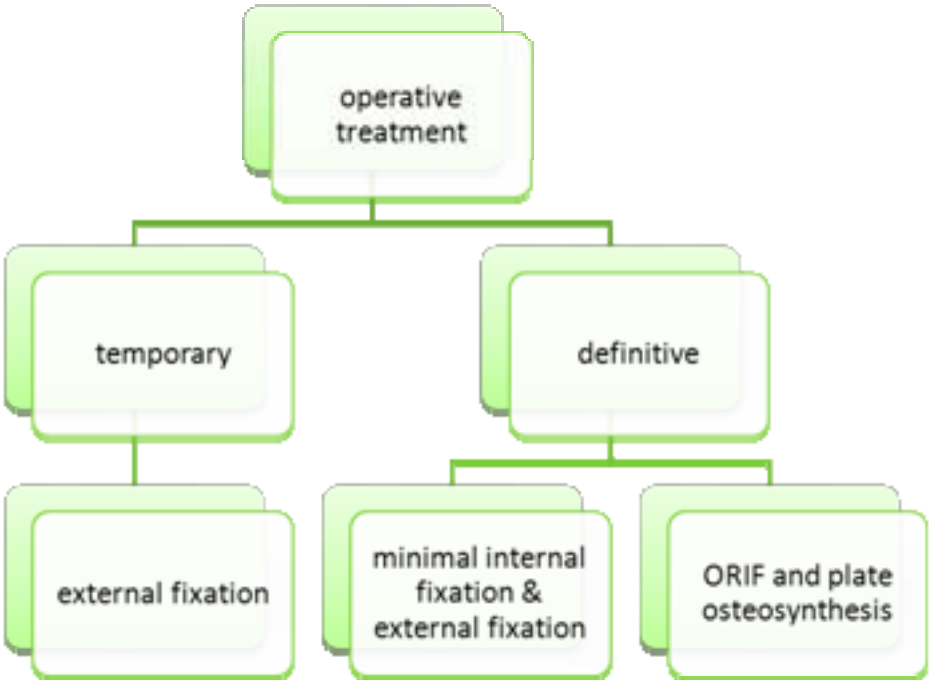
The standard technique should involve antero-posterior (AP) and lateral view of the concerned extremity and adjacent joints.

CT SCAN:

Standard tomongraphy is helpful in documenting articular surface deformity, fracture comminution and osteochondral lesion of the femur, tibia and humerus. It also gives s data about the displacement of fracture fragments, articular surface depression, and bone loss. Computerized Tomography scan is important in all cases that are evaluated for open reduction and internal fixation as it can give complete delineation of the position, size and shape of the various fragments.

METHODS OF TREATMENT

In a patient with vascular injury the displaced fragments fragments has to aligned and fixed. Otherwise manipulation of fragments after repair can lead to disruption of vascular anastamosis. So the length and alignment the bone can be maintained with external fixator or femoral distractor. If vascular repair is done initially a redundancy of the graft is kept for later manipulation of fragments.



EXTERNAL FIXATION

External fixation has evolved as an integral component in the management of open and closed fractures associated with vascular injury, and can be used as a definitive treatment method or in

combination with staged open reduction and internal fixation

ADVANTAGES

1) In external fixation a minimum of metal exists inside the tissues.

2) The fracture fragments are at will realigned, distracted or compressed.

3) The wound area are well exposed, local lavage, flushing, dressing and surgical procedures are very easy and convenient and cause minimal discomfort to the patient.

4) Efficient stabilization of the fracture fragments facilitates limb elevation and early movements of adjacent joints.

DISADVANTAGES

1) Pin site infection

2) Pin site loosening

3) Semi rigid construct.

4) Pin site infection and loosening also causes problems while conversion into internal fixation

Half pins (Shantz screw) are the mainstay of the external

fixator. It is a modified cortical screw . It has threads at one end and rounded tip at the other. It is self tapping and 4.5 mm for lower limb and humerus and 3.5mm for forearm was used.

The types of external fixation are

1) Joint Sparing External Fixation

2) Spanning external fixation

JOINT SPARING EXTERNAL FIXATION:

These types of fixation help in early joint mobilization and post-operative rehabilitation. In tibia fracture 3 pins are placed in each fragment and the pins are oriented medio laterally.In femur fracture 3 pins are placed in each fragment oriented from lateral to medial direction. In Humerus fracture 2 pins are placed in each fragment . Proximally pins are oriented from lateral aspect and distally from posterior and connected with interconnecting rods.

SPANNING EXTERNAL FIXATION

Spanning external fixation may be used temporarily before definitively stabilizing the fracture by another method or as the definitive method to neutralize forces during fracture repair. In either case, the advantage of this method is technically the easiest to apply and is also the safest because the zone of injury is

spanned.In distal femur fracture,tibial plateau fracture, proximal tibia fracture and knee dislocation 3 pins are placed in femur from lateral aspect and 3 pins from medial aspect and connected with interconnecting rods.

INTERNAL FIXATION

It can be used a primary modality of treatment in patients with closed and stable fractures with shorter duration of ischemia of 6 hrs[16]. Also in patients with open fractures it can be used a secondary modality of treatment once the soft tissue wound healed or infection gets controlled with external fixators. In closed fracture shaft of femur with associated vascular injury depending on the site and nature of fracture either nailing or plating can be done. Plate can be placed medially on the shaft of femur through the same approach for the femoral artery. In patients with plate we should inform the patient the chance of non union and infection.

In patients with delayed presentation with more than 6hrs temporary synthetic arterial shunt and attaining revascularization and immediate definitive stabilization can be done in the form nail or plates depending on the site and type of of fracture.Followed by definitive repair of the vessel.

Minimal internal fixation along with external fixation in the form of K wire and screw fixation can also be done periarticular fractures to align the articular fragment to maintain articular

congruence. Implants used for internal fixation vary depending on the site of the fracture buttress plate for tibial plateau, LCP for distal femur , 4.5 LC-DCP,LCP and Nail for shaft of femur and 4.5,3.5 LC_DCP&LCP for shaft of humerus .

TYPES OF VASCULAR INJURIES AND REPAIR

Vascular injury can be open or closed.

Open injuries are caused by

1) complete division or laceration

2) traumatic arterio venous fistula

3) Pulsating hematoma(traumatic false aneurysm).

Closed injuries are

1) External compression by bone fragments or soft tissue

2) Thrombosis

3) Intimal tears

4) Spasm

Simple lacerated arterial injury is repaired with either a vein or Dacron patch. In case of severe lacerated wound or completely torn vessel either an end to end anastamosis or bye-pass venous graft can be done. If the vessel is found to de contused or thrombosed ,artery is opened longitudinally at the site of injury all the clot are extracted .Then distally all the occluding material is released and checked for back out of blood which indicates patency

of the vessel distal to the injured level.

In case of spasm needle is inserted into the vessel proximally and distally vessel is occluded to a short segment, then heparinised saline is infused till the segment is distended. By this entire segment is examined to identify the site of occlusion also it relieves the spasm. Otherwise local papaverine application can relieve spasm which is less effective.

COMPLICATION

As with any other surgical procedure there is a potential risk for infection. Prophylactic antibiotic is given in the emergency room itself. Pin site has to be taken care of to prevent pin site infection.

Delayed union and non union can result as a result of impaired vascularity.

And osteomyelitis is a potential complication in patient with open injury.

Compartment syndrome is another devastating complication leading to impairement of microcirculation resulting in ischemia and irreversible damage to muscle , nerves and delayed bone healing.

Graft thrombus is a potential complications has to be carefully looked for in post operative period. In these case graft failure is mostly due to small vessel thrombosis and inadequate heparin use.

Prolonged immobilization can lead to deep vein thrombosis and fatal thromboembolism.

In patients with prolonged ischemia, on reperfusion crush syndrome can occur. It can cause renal failure and DIC leading to death of patient.

MATERIALS AND METHODS

This was a prospective study conducted at Rajiv Gandhi Government General Hospital from August2011 to September 2012. Study has been conducted in thirty one patients.

31 Patients admitted in emergency ward with fractures and associated with vascular injury was taken into this study. The study was approved by the ethical committee of the hospital and informed consent has been obtained from the patient.

All patients has been taken up for surgical intervention both for vascular repair by vascular surgeons and skeletal fixation by us. Wounds were classified into open and closed. For Grade IIIA &III B wounds plastic surgeon opinion and if needed intervention has been done.

INCLUSION CRITERIA

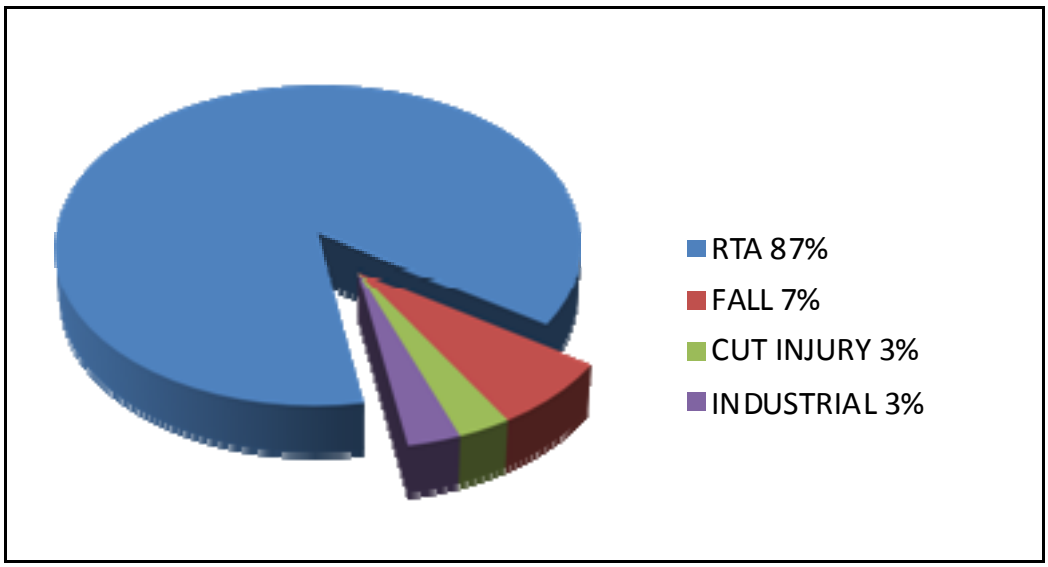
- Age >18 years
- Fracture of femur,tibia,humerus ,radius and ulna with vascular injury
- Knee and elbow dislocation with vascular injury
- Class I&II ischemia
- MESS score ≤ 8

EXCLUSION CRITERIA

- ❖ Crush injury
- ❖ Train traffic accident
- ❖ Poly trauma patient (associated with abdomen and chest injury)
- ❖ Class III ischemia
- ❖ MESS score > 8

PREOPERATIVE EVALUATION

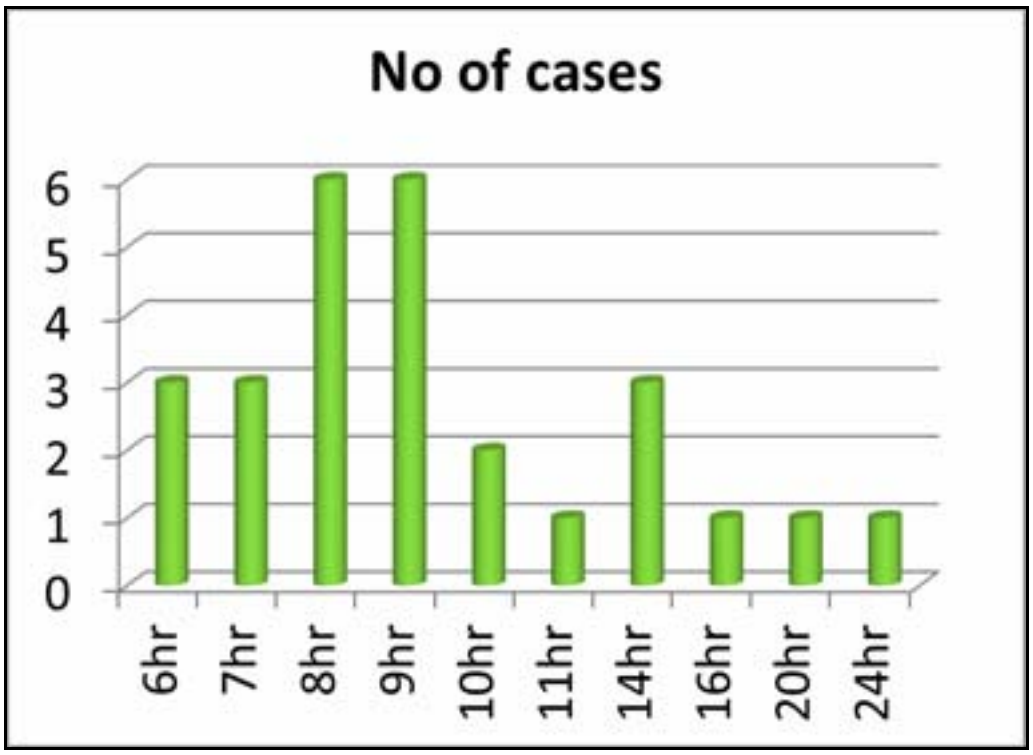
Mode of injury and duration between injury and repair was note



DURATION BETWEEN INJURY AND REPAIR:

Average delay between injury and repair was 10.25 hrs range between 4 hrs and 24 hrs in 28 patients.

Three patients presented late with two patient of 3 days and one patient of 4 days old injury.



Patient hemodynamic status assessed and resuscitation done with crystalloid, colloid and blood transfusion. Then the wounds were classified into open and closed. Open wounds were further classified according to Gustilo and Anderson classification. Mangled Extremity Severity Scoring was done.

Grade IIIA and Grade IIIB open tibial wounds were further

subclassified according to Rajasekaran et all classiification.

Then the patient vascular status was assessed with clinical and Doppler findings. Ankle Brachial index was calculated. Then ischemia was graded according to International Vascular Surgery classification of Acute Limb Ischemia. Heparin was given 5000 IU IV stat in all cases.

Patients with Grade I and Grade II ischemia were taken revascularization procedure. Thorough debridement done for open cases and fracture aligned,shanz pin was inserted in proximal and distal fragments and then revascularisation was proceeded. In most of the cases (27 cases) revascularization was done with Reverse Saphenous venous Byepass Graft. Embolectomy was done in two cases and relief of spasm by local papaverineapplication was done in one case.

During revascularization procedure length of the saphenous graft was given about 2 cm longer. After vessel repair, flap cover was done for feasible cases without gross contamination.

Vascular procedure	No of cases	Percentage
RSV Graft	27	87%
Thrombectomy	2	6.5%
Topical papaverine application	1	3.25%
Observation	1	3.25%

Prophylactic Fasciotomy was done in all cases of vascular repair. Double incision fasciotomy in fractures of femur or tibia to release all the four compartments anterior,lateral and posterior(superficial and deep) of leg was done. Then External fixator was connected.

Of the 31 cases External fixation alone has been done in 19 cases and external fixation with minimal internal fixation in the form of K wire and cancellous screws in 3 of the cases.

In cases of Fracture Shaft of femur, FractureShaft of humerus and Fracture Both Bone leg unilateral uniplanar External fixation was done.

In cases of Fracture tibialplateau, Fracture proximal tibia, Knee dislocation, Fracture distal humerus and elbow dislocation joint spanning external fixation was done.

In 4 cases with closed fracture primary internal fixation with plate osteosynthesis was done. For one cases of femur fracture BDCP plating,one humerus fracture with BDCP plating and two proximal tibia fracture buttress plating has been done.

MODE OF TREATMENT	NO OF CASES
External Fixation alone	19
External fixation with minimal internal fixation	3
Minimal internal fixation alone	1
Primary External Fixation /Secondary ORIF & Plating	4
Primary ORIF & Plating	4

Once the fasciotomy wound is fit, SSG was done for the fasciotomy wound on an average of about 5 to 7 days .Internal fixation was proceeded once the SSG wound and other soft tissue has healed. In 4 cases Secondary internal fixation was done after 1 month.For one case of fracture shaft of humerus posterior approach is used, For 2 cases of fracture shaft of femur and one case of supracondylar femur lateral approach is used.

IMPLANTS USED

EXTERNAL FIXATOR

POSTOPERATIVE PROTOCOL

Patient limb is clinically examined on 1st post operative day for signs of ischemia like cold extremity, Pallor, pareasthesia, paresis and pulselessness. Ankle brachial index was calculated.

Inj.Heparin 5000 IU iv qid,T.Allopurinol 100mg bd, and T.Aspirin1/2 od was started.IV antiobiotics given.Wound dressing changed daily.

Then followed up for 2nd and 3rd postoperative day for viability of limb. In patients in whom internal fixation was done active knee and elbow mobilization started on 3 post operative day once vascularity has been regained .

Once the vascularity of the limb has been regained .soft tissue management is done in open wounds .Multiple debridements are done for patients with extensive soft tissue damage.If infection present pus culture and sensitivity was done and antibiotics started accordingly.

For patients with extensive soft tissue loss once the infection controlled flap cover was done.In patients with no major soft tissue problem and in closed fractures. fasciotomy wound is examined on

alternate days .once the wound is fit SSG was done.

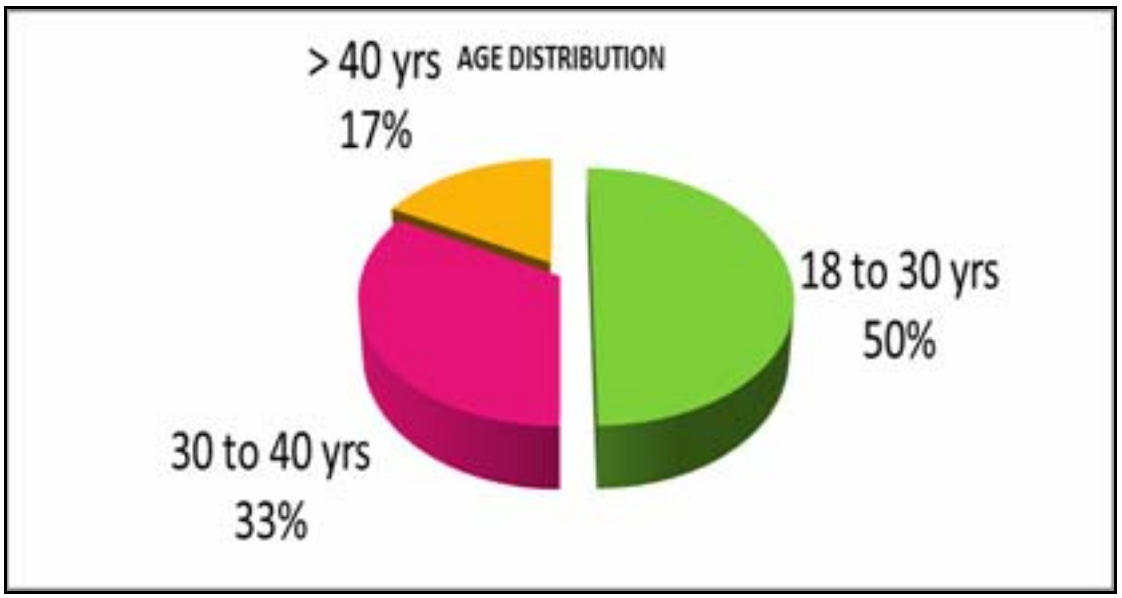
In patients with proximal tibia fracture and fracture both bone leg after 2 to 3 weeks if the fracture pattern allows knee spanning external fixation are converted to knee sparing external fixation and knee mobilization started. Then serial X-rays are taken to assess the union of bone. Once the bone is consolidated and radiological union occurred exfix is removed and patient is allowed to weight bear.

In patients treated with external fixation alone it takes 3 to 4 months to get back to his normal activities.

OBSERVATION AND RESULTS

1. Mean age of the patients at the time of presentation was 30.9 years (range: 17-50 yrs). Majority of them were male (29pts), with RTA was the predominant mode of injury (27cases)

AGE DISTRIBUTION



SIDE INVOLVED:

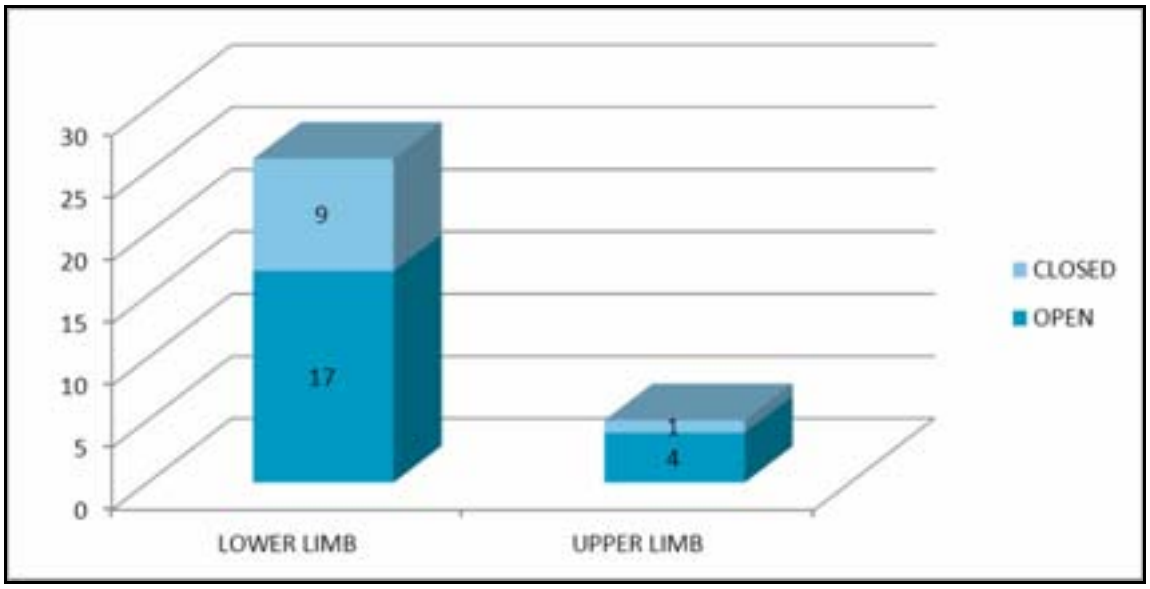
In upper limb fractures of 5cases 3 cases of dominant right side and 2 of left side. In lower limb fractures equal distribution of right and left side was present.

Side	No. of Cases	Percentage
Right	19	61%
Left	12	39%

- There were 29 males and 2 females with M:F ratio of 9.3 : 0.7
- Mode of injury was RTA in 27 patients (87%) of which fall from riding a two wheeler predominated .
- Lower limb was most commonly involved(26 cases) and commonest bone fractured was Tibia

Fractures	No of cases	Percentage
# BB leg orProximal tibia	13	42%
# Distal femur and tibia	3	10%
# Supra Condylar Femur	3	10%
# Shaft of femur	6	19%
# Shaft of humerus	3	10%
#Distal radius	1	3%
Knee dislocation	1	3%
Elbow dislocation	1	3%

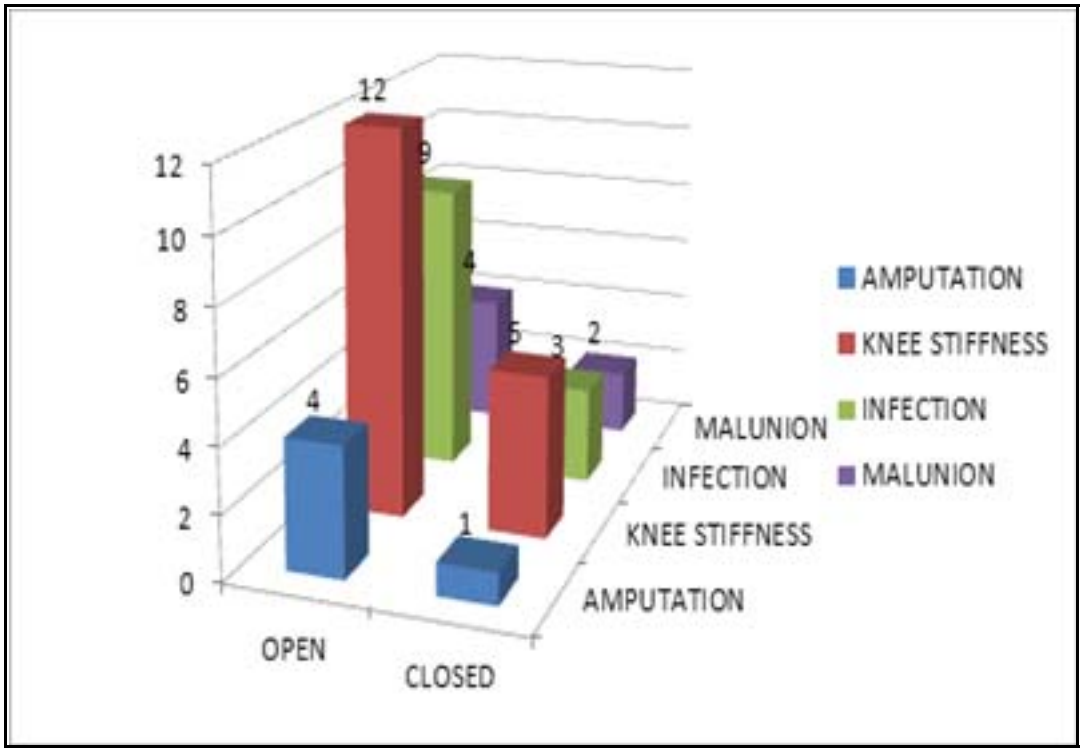
5.Closed fractures with vascular injury occurred in 10 cases and Open injury in 21cases.



Artery injured	No of cases
Femoral artery	4
Femoral vein	1
Popliteal artery	21
Brachial artery	4
Radial artery	1

Most common artery to be involved was Popliteal artery (21 cases) In 4 patients with closed fractures with immediate primary fixation there was one delayed union in shaft of femur, and superficial infection in one case of proximal tibia.

In all 12 cases of open injuries with fractures with viable limb all developed knee stiffness. In 8 closed fractures with viable limb 5 knee stiffness. Knee stiffness developed in patients treated with external fixation primarily.



Infection was present in 12 cases of lower limb fractures, 9 were open injuries and 3 closed injuries. Repeated debridement required in 5 cases.

Malunion developed in six cases treated with external fixation alone.

Patients with less ganga hospital scoring had improved outcome in the form of early soft tissue healing and early rehabilitation. One patient with MESS score of 8 and Ganga Hospital Score of 15 expired because of crush syndrome.

Mess Score	Ganga Hospital Score
6	4
7	6
7	11
8	10
8	9
7	9
7	7
8	15
5	6

13. ASSOCIATED INJURIES

Injuries	Associated injuries
# SOH	Median Nerve
# BB Leg	Tibial Nerve Injury
Knee dislocation	Tibial Nerve Injury
# SOH	# NOF,#Distal Radius, Median nerve injury
# SOH	# Distal Radius&DRUJ Disruption
# BB Leg	Popliteal Vein
Rt # BB Leg & Rt #SOF	Lt # BBLeg

In 4 cases of brachial artery injuries 3 patient had associated median nerve injury.

Delay in the union of bones noted and approximately of 3 months.

5 patients had above knee amputation after vascular repair .It was done in 4 patients with open injuries and 1 with closed injuries. 4 due to graft failure and 1 due to infection. Amputation rate was 16%. 4 cases presented late with more than 10 hours duration between injury and repair. Also gross soft tissue loss was present.

There was 1 death due to crush syndrome.

Reverse Saphenous vein graft was the vascular repair done in 27 cases.

There was a mean hospital stay of 4 months with open grade III injuries.

CASE ILLUSTRATION

CASE -1

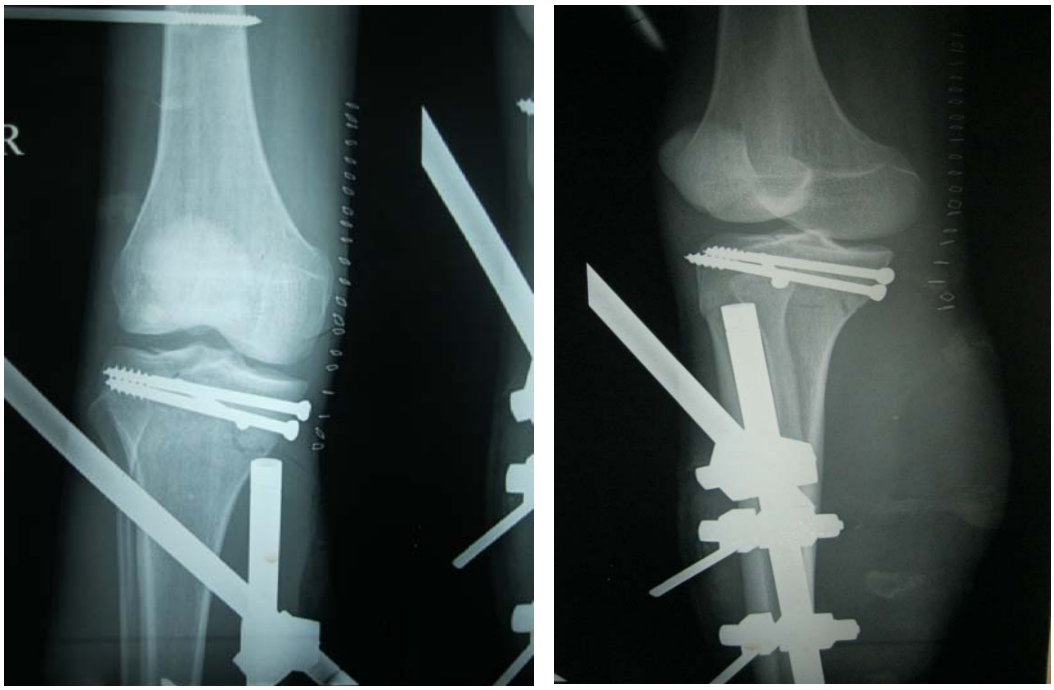
Name	:	Dasa prakash
Age/sex	:	20/M
Diagnosis	:	Closed fracture tibial plateau Schatzker type IV with popliteal artery injury
Procedure done	:	Popliteal repair with reverse saphenous vein graft and Internal Fixation with cancellous screw and knee spannimg external fixation with fasciotomy
Second P/D	:	SSG
Followup	:	4 Months
Complication	:	Knee stiffness (ROM: $0\text{-}90^0$)

CASE-I

Pre OP

Intra OP

Immediate Post Op



3 Months Post OP

Range of Movement

CASE -2

Name	:	Saravanan
Age /sex	:	29/M
Diagnosis	:	Closed fracture shaft of femur with popliteal artery injury
Pocedure done	:	Vascular repair with reverse saphenous vein graft and knee spanning external fixation with fasciotomy
Second procedures	:	Wound debridement twice SSG ORIF and BDCP plating with bone graft
Followup	:	5 Months
Complication	:	Infection, Knee stiffness $0\text{-}30^0$

CASE-2

Pre op X-Ray

Post op clinical photo

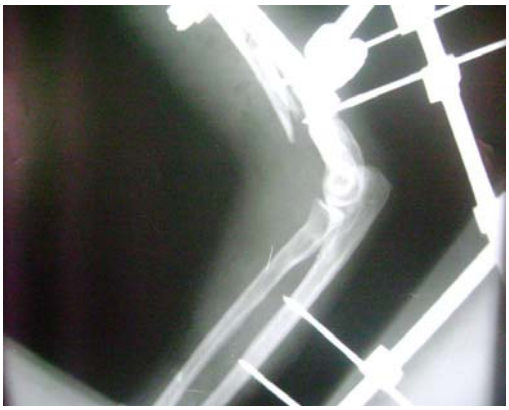
2 Months POst Op

Range of Movements

CASE-3

Name	:	Manivannan
Age/Sex	:	27/M
Diagnosis	:	Fracture shaft of humerus Right with brachial artery injury
Procedure	:	Brachial artery repair with RSV graft .
Second procedure	:	ORIF &BDCP plating
Followup	:	4 Months
Complication	:	Median Nerve Injury

Pre OP ***Immediate Post Op***

Immediate Post Op after 2nd Procedure

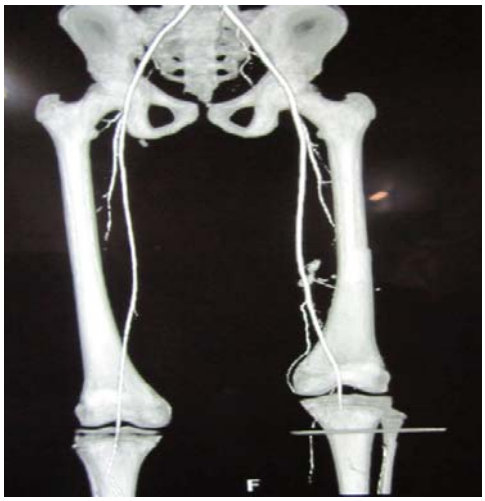

2 ½ Months Followup ***Post Op Clinical Picture***


CASE-4

Name	:	Moovesh
Age/sex	:	17/M
IP.No	:	47687
Diagnosis	:	Fracture shaft of femur with popliteal artery injury 4 days old
Procedure done	:	ORIF&BDCP Plating
Followup	:	1 Month

Pre OP

CT Angiogram



Post Op

COMPLICATIONS

Infection

Soft Tissue Loss

Gangrene

Malunion

Amputation

DISCUSSION

In patients with fractures or dislocation associated vascular injury may be due the effect of direct trauma or fracture fragments may tent on the vessel causing occlusion. Immediate decision has to be taken to avoid serious catastrophe of limb amputation in such patients.

Most of the scoring systems to the asses viability of the limb lack sensitivityand none of the scoring systems had 100% negative predictive value.Even limb with more scores limb can be saved by multidisciplinary team of plastic surgeon,vascular surgeon and orthopeadician.

The time of preoperative evaluation should be as short as possible to minimize ischemia time and thus prevent potential necrotic changes. The severity of ischemia depends not only on its duration but also on the level of arterial injury, extent of soft tissue damage, and efficiency of collateral circulation.

The average age in a series by T.M. Mirdad [6] 29.6 yrs and male to female ratio of 9.8 to 1 which suggest that these serious injuries occur in people engaged with active and probably dangerous activities in the most productive stages of life. In our

study mean age was 30.9 years with a male to female ratio of 9.3 to 0.7.

In T.M.Mirdad[6] study road traffic accidents were primarily responsible for this type of injury (67.4%).In our study also road traffic accidents predominate in 87% of patients.

Early application of systemic anticoagulation therapy[4] (heparin 100 U/kg i.v) reduces amputation rate .It also prevents thrombosis in microcirculation. In our cases the anticoagulant treatment was initiated in the emergency if systemic anticoagulation was not contra-indicated (active haemorrhage, coagulopathy and craniocerebral injury) in the dose of 5000 IU i.v stat(100 U kg/i.v).

Then the decision is to be taken whether to fix the fragment first or to vascular repair .And also to do definitive or temporary fixation. Starr et al[2] in his study on 19 patients with femoral fractures in 10 patients he performed primary internal fixation followed by vascular repair and in 9 patients initial vascular repair followed by internal fixation he found no difference .In their study he used temporary shunts in patients with prolonged ischemia time.

Omer Cakir[4] in his study preferred primary vascular repair in cases involving stable fractures. Then after fixation checked for damage to the vascular structures. With unstable fractures they performed bone fixation prior to vascular repair.

In our study we performed vascular repair primarily in all cases before bone fixation and checked for vascular damage after fixation. Graft failure was in 4 cases.

Iannacone[1] in his study in patients with associated injury and for time constraints he temporarily stabilized the fragments with external fixator in femoral shaft fractures then converted into exchange nailing or plating.

Di Christina et al[3] in 8 open femoral fractures 3 patients had persistent discharge and 2 patients had AK amputation. None of the patient had more than 90° of knee flexion whereas there is full range of knee motion in patients with closed fractures. In our study all patients with open injuries had decreased range of knee motion.

In our study 7 patients with open femur fracture had knee stiffness and range of motion was <90°.

In patient ischemia duration less than 6 hours and more soft tissue disruption Askin Ender Topal[8] performed prophylactic fasciotomy. Major soft tissue defect render vascular repair impossible . Even if repair is possible it may cause development of compartmental hypertension by interrupting collateral blood supply to distal arteriolar bed. In his study he also concluded prophylactic fasciotomy prevents development of compartmental hypertension in those with 2- bone fractures below knee multiple arterial injuries and gross soft tissue disruption.

Omer Cakir also showed doing fasciotomy in vascular injuries associated with orthopedic trauma decrease the risk of compartment syndrome

Omer Cakir[4] in a series of 192 cases between 1982 to 2005 preferred external fixation in majority of cases of about 76 cases. The advantage include less tissue destruction, less operative time for immobilization and less potential for infection in contaminated wounds. Also daily debridement and irrigation of the wound in case of severe soft tissue injury.

Repair of concomitant venous injuries is recommended this prevents post operative edema and keeps the arterial repair open.

Proximal vein injuries like axillary vein,brachial vein in the arm and femoral vein has to be repairedprimarly to improve outcome .

Treatment of vascular trauma also includes appropriate management of soft tissue injury.Multiple debridements were needed in several of our patients to control the infection.

CONCLUSION

1) Assessment of vascular injuries in fractures and dislocation based on clinical examination and hand Doppler reduces the assessment time than on imaging.

2) Patients with Grade I,II & IIIA injuries with vascular injury internal fixation is the ideal method to fix the fracture.

3) Initial management with external fixation allows time to assess the viability of limb,edema to subside and soft tissue to recover.

4) Delay in surgery and extensive soft tissue injury are associated with increased amputation rate.

5) In closed injuries with stable fracture can be stabilised through the same approach undertaken for vascular repair

6) Earlier rehabilitation reduces joint stiffness and improves muscle power.

7) Early intervention prevents myonecrosis and its complication.

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PROFORMA

Case No : Hospital :

Name : I.P.No. :

Age : D.O.A. :

Sex : D.O.D. :

Address : Occupation :

DIAGNOSIS :

I) HISTORY :

Complaints : Pain

Mode of injury: RTA

Fall

Stab

Industrial

Time of injury :

Site of injury :

Loss of consciousness:

II) PAST HISTORY :

III) FAMILY HISTORY :

IV) GENERAL PHYSICAL EXAMINATION :

Pallor

B.P.

P.R.

Temp.

V) SYSTEMIC EXAMINATION :

CVS

RS

P/A

CNS

VI) LOCAL EXAMINATION :

i) Inspection :

Swelling

Wounds

a) Number of wounds

b) Nature of wound

Closed
Open
Grade I
Grade II
Grade III

ii) Palpation :

Warm or cold

Tenderness

Abnormal mobility

Crepitus

Movements :
Active
Passive

iii) Neurovascular status :

Distal pulses

iv) Associated injuries

Head
Chest
Abdomen

vi) Complications (if any)

VII) MANAGEMENT :

A) Investigations :

1) Blood : Hb% 2) Urine : Albumin

TC Sugar

DC Deposit

ESR

3) Blood urea : 4) HIV

Blood sugar: HBsAg

S.creatinine: 5) ECG

6) X-ray of concerned extremity AP and Lateral

7) Doppler examination of distal pulses

126

B) Treatment :

i) Surgical procedure

ii) Indication

iii) Date of surgery

iv) Type of Anaesthesia

v) Implant used

vi) Antibiotics used

vii) Immobilization after surgery

- Type

- Duration

viii) Check x-ray :

ix) Rehabilitation :

VIII) COMPLICATIONS :

IX) FOLLOW UP :

PATIENT CONSENT FORM

STUDY TITLE: Functional outcome analysis of vascular injury in long bone fractures and dislocation

STUDY CENTRE: Institute of Orthopaedics and Traumatology
Rajiv Gandhi Govt. General Hospital and Madras Medical College
Chennai-3

Patient's Name :_____

Patient's Age :_____

Identification Number :_____

I confirm that I have understood the purpose and procedure for the above study. I have the opportunity to ask the question and all my questions and doubts have been answered to my complete satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected.

I understand that the sponsor of the clinical study, others working on the sponsor's behalf, the ethics committee and the regulatory authorities will not need my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the study. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arose from this study.

I agree to take part in the above study and to comply with the instructions given during the study and to faithfully Co-operate with the study team, and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms.

I hereby consent to participate in this study of "Functional outcome analysis of vascular injury in long bone fractures and dislocation

I hereby give permission to undergo complete clinical examination, and diagnostic tests including hematological, biochemical, radiological, urine examination.

Signature / Thumb impression _____Place_____Date _____

Of the patient\

Patient's Name &Address: _____

_____

Signature of the Investigator: _____ Place_____Date _____

Study Investigator's Name: _____

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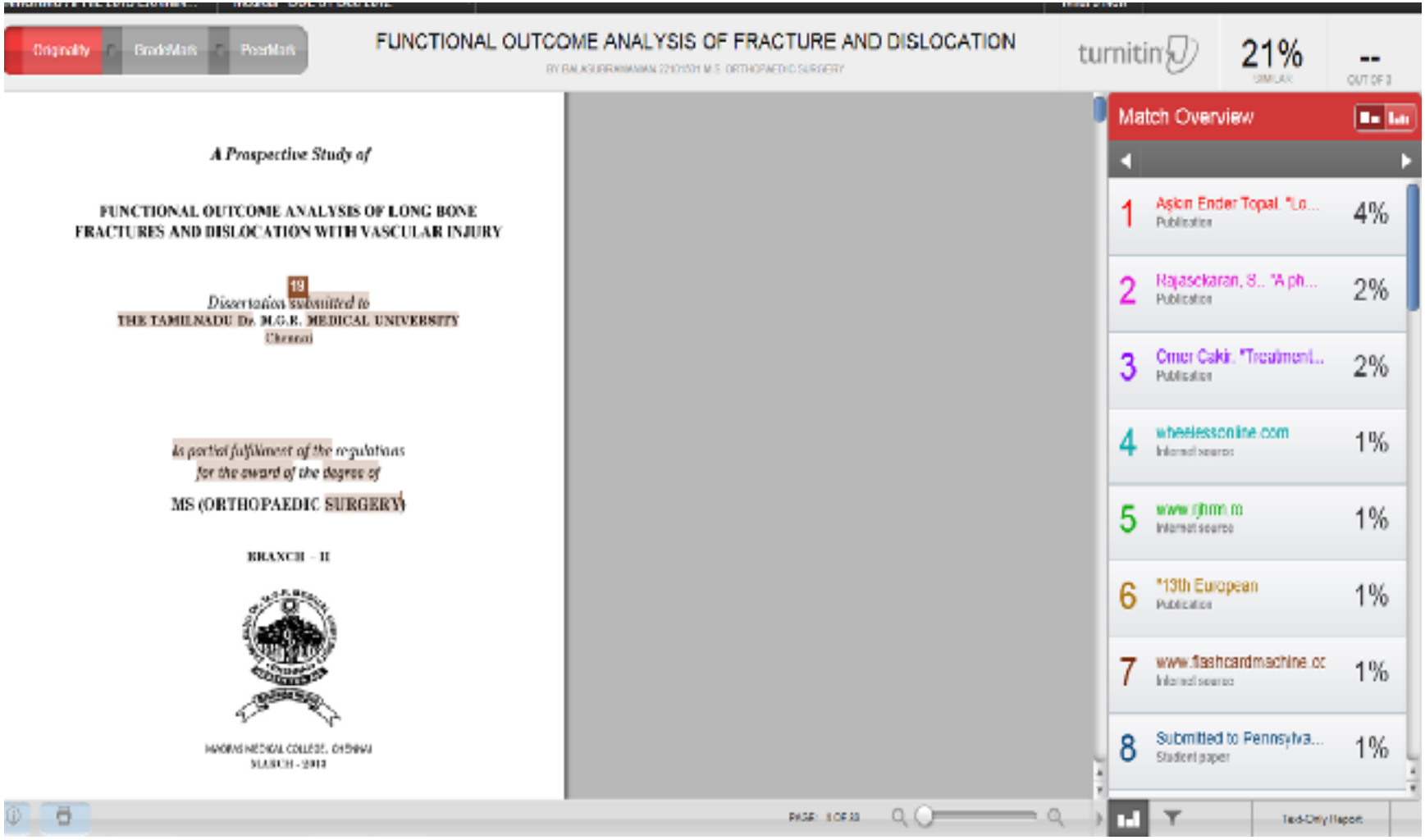
A Prospective Study of FUNCTIONAL OUTCOME ANALYSIS OF LONG BONE FRACTURES AND DISLOCATION WITH VASCULAR INJURY Dissertation submitted to THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY Chennai In partial fulfillment of the regulations for the award of the degree of MS (ORTHOPAEDIC SURGERY) BRANCH – II MADRAS MEDICAL COLLEGE, CHENNAI MARCH - 2013 CERTIFICATE This is to certify that this dissertation in “Functional outcome analysis of long bone fractures and dislocation with vascular injury” is a bonafide work done by G.Bala Subramanian under my guidance during the period 2010–2013. This has been submitted in partial fulfillment of the award of M.S. Degree in Orthopedic Surgery (Branch–II) by the...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Dissertation submitted to
THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY
Chennai
In partial fulfilment of the regulations
for the award of the degree of
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CERTIFICATE OF APPROVAL

To
Dr. Bala Subramanian
PG in MS Orthopaedics
Madras Medical College, Chennai -3

Dear Dr. Bala Subramanian

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled "functional outcome analysis of vascular injury in long bone fractures and dislocation " No.25092012.

The following members of Ethics Committee were present in the meeting held on 13.09.2012 conducted at Madras Medical College, Chennai -3.

1. Dr. S.K. Rajan. M.D.,FRCP.,DSc	-- Chairperson
2. Prof. Pregna B. Dolia MD Vice Principal, Madras Medical College, Chennai -3 Director , Institute of Biochemistry, MMC, Ch-3	-- Member Secretary
3. Prof. B. Vasanthi MD Professor of Pharmacology ,MMC, Ch-3	-- Member
4. Prof. M. Reghu MD Director, Inst. Of Internal Medicine, MMC, Ch-3	-- Member
5. Prof. MD. Ali. MD.DM Prof & HOD of MGE, MMC, Ch-3	-- Member
6. Prof. P. Karkuzhali. MD Director i/c, Prof., Inst. of Pathology, MMC, Ch-3	-- Member
7. Prof. Bavani Shankar. MS Prof of General Surgery, MMC, Ch-3	-- Member
8. Thiru. S. Govindsamy. BABL	-- Lawyer
9. Tmt. Arnold Soulina MA MSW	-- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

Member Secretary, Ethics Committee

MASTER CHART

S.No	Name	Age/ Sex	R/L	Grade	Wound grade	Artery injured	Mode of injury	MESS SCORE	GHS	Duration of injury & repair	Primary procedure	Secondary procedure	Infection
1	Sundar	31/M	L	Open IIIC# distal femur and proximal tibia	IIIA	PA	RTA	6	4	9hr	Knee Spanning External fixation and vascular repair	SSG	+
2	Kannayiram	18/M	L	Open IIIc# BB leg with vascular injury	III B	PA	RTA	8	10	8hr	Knee spanning External fixation with vascular repair	Graft failure & AK amputation done on 08/11	
3	Karthick	17/M	R	Open IIIC# BB leg	IIIA	PA	RTA	7	6	8hr	WD & Tibial External fixation and vascular repair	SSG	
4	Mani	27/M	R	Closed IIIC# Shaft of humerus		BA	RTA	3		8hr	External fixation and vascular repair	ORIF and Plating	
5	Ravi	42/M	L	OpenGrade IIIC # BB leg	IIIA	PA	RTA	7	11	7hr	WD and Knee spanning external fixation and vascular repair	Graft failure & AK amputation done on 30/04	
6	Saravanan	17/M	R	Closed IIIC# BB leg proximal 1/3		PA	INDUSTRIAL	7		9hr	Knee spanning External fixation and vascular repair with fasciotomy	SSG	+
7	Ganapathy	18/M	L	Open III C# shaft of femur	III B	FA	RTA	8		8hr	WD & Knee Spanning External fixation with vascular repair	SSG	+
8	Thillainayagi	35/F	L	Open Posterior disloication knee	II	PA	RTA	6		6hr	Knee spanning external fixation	SSG	

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9	vishwanatha n	35/M	R	with popliteal artery injury Open Elbow dislocation with brachial artery injury	IIIA	BA	FALL	7		9 hrs	and vascular repair &f asciotomy WD & elbow spanning exfix, vascular repair		+
10	Praveen	17/M	R	Closed # SOF WITH tibial Epiphyseal injury popliteal artery injury		PA	RTA	6		14 hrs	Vascular repair with knee spanning external fixation and BDCP Femur and k wire for tibia	Graft failure and AK amputation on 31/06/12	
11	moovesh	17/M	L	Closed # SOF On 17/05/12 with vascular injury		FA	RTA	6		6 days	ORIF WITH BDCP	SSG for raw area over foot	
12	Muniappan	40/M	L	Open IIIC# Humerus	II	BA	FALL	8		3 days	WD & elbow spanning exfix, vascular repair & flap cover with STSG	ORIF and Plating	
13	Suresh	24/M	L	OpenIIIC # SC Femur	II	PA	RTA	7		10 hrs	Knee spanning external fixation and vascular repair	SSG	+
14	Parthiban	20/M	R	Open IIIC# SC Femur	III A	PA	RTA	7		4 hr	vascular repair & Minimal internal fixation with Steinman pin	Graft failure and AK amputation on 17/07/12	
15	Venkatesh	40/M	R	Open IIIC# Proximal tibia	III A	PA	RTA	8	9	9 hr	Knee spanning external fixation and vascular repair	SSG	+
16	Natarajan	42/M	R	Open IIIC# SOF&#Tibial Plateau	IIIB	PA	RTA	7	9	8 hr	Knee spanning external fixation	SSG	+

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17	Velumani	35/M	L	Open IIIC# BB Leg	III A	PA	RTA	7	7	9hr	and vascular repair &f asciotomy Knee spanning external fixation and vascular repair &flapcover	SSG	
18	Yesupandi	19/M	R	Open IIIC# SOF	IIIB	F.Vein	RTA	5		6 hrs	Knee spanning External fixation and vascular repair		+
19	Muruganan dham	32/M	R	Open IIIC# BB Leg	II	PA	RTA	8		20 hrs	Knee spanning external fixation and vascular repair and flap cover	SSG and Flapcover	+
20	Nataraj	50/M	L	Closed fracture # tibia with popliteal artery injury		PA	RTA	7		14 hrs	Tibial exfix & vascular repair with graft	Gross inection& AK amputation done	+
21	Yasodha	40/F	R	Open IIIC# distal radius	II	RA	STAB	7		14 hrs	Vascular repair and ligamentotaxis		
22	Saravanan	29/M	R	Closed # SOF, # Patella		FA	RTA	7		10hrs	Knee spanning external fixation,TBW and vascular repair	SSG and ORIF with plating	+
23	Ravi	34/M	R	Closed fracture # BB leg with vascular injury		PA	RTA	5		7 hrs	Knee spanning external fixation and vascular repair	SSG	
24	Moorthy	37/M	R	Closed supracondylar # with popliteal artery injury		PA	RTA	7		15 hrs	Thrombectomy and Knee spanning external fixation and fasciotomy	ORIF and LCP plating	+

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25	Partha sarathy	48/M	L	Open IIIC# BB Leg with tibial plateau # with # SOF	III B	PA	RTA	8	15	8 hr	Vascular repair with graft and knee spanning Exfix	Patient Expired	
26	Thanigaivel	20/M	R	Open Proximal tibia with Knee subluxation with popliteal A injury	IIIA	PA	RTA	5	6	11 hrs	Vascular repair with graft and knee spanning Exfix	SSG and flap cover	
27	Sivakumar	41/M	L	Closed #B/L BB Leg	II	PA	RTA	6		16 hrs	Vascular repair with graft and knee spanning Exfix	SSG	
28	Mehaboob basha	30/M	R	Open IIIC # SOF	II	FA	RTA	4		3 days	Vascular repair with graft and knee spanning Exfix	SSG	
29	Dasa Prakash	20/M	R	Closed Tibial Plateu #		PA	RTA	4		24 hrs	Vascular repair with graft and knee spanning Exfix & cancellous screw	SSG	+
30	Tirupathi	47/M	L	Open # SOH	II	BA	INDUS TRIAL	5		7 hrs	ORIF with plating with vascular repair with graft	SSG	
31	Palvannan	23/ M	R	Closed # Proximaltibia		PA	RTA	5		9 hrs	ORIF with plating with vascular repair with graft	SSG	

MASTER CHART

Sl.no	Duration of surgery	Antibiotics	septicarthritis	malunion	Associated injuries	Associated fractures	**Knee stiffness**	VAS
1	220 min	Inj taxim		+			10 to 90°	
2	200min	Iny taxim						
3	220 min	Inj taxim					0 to 110°	
4	190min				Median Nerve			
5	210 min							
6	200 min				Tibial nerve		0 to 100°	
7	190 min		+	+			0 to 40°	
8	240 min				TibialNerve		10 to 60°	
9	190 min				Median Nerve	# distal radius		
10	210 min							
11	220 min							
12	240 min							
13	190 min			+			0 to 90°	
14	210 min							
15	230min			+	Popliteal vein		0 to 90°	
16	260 min			+			10 to 70°	
17	250 min						10 to 120°	
18	240min						O to 80°	
19	230 min						10 to 50°	
20	200 min							
21	190 min							
22	240 min						10 to 40°	
23	250min						10 to80°	
24	220 min			+			10 to 90°	
25	200 min							
26	190 min			+			10 to 90°	
27	230 min							
28	240 min						10to 100°	
29	200 min						10 to 80°	
30	190 min							
31	230 min							

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